DOCUMENT RESUME

ED 242 015 EA 016 467

AUTHOR Metzger, Merrianne; And Others
TITLE Learning Disabled Students and Computers: A Teacher's Guide Book.
INSTITUTION International Council for Computers in Education, Eugene, Oreg.
PUB DATE 83
NOTE 52p.
AVAILABLE FROM Publications, International Council for Computers in Education, 1787 Agate Street, University of Oregon, Eugene, OR 97403 ($2.50 prepaid; quantity discounts; on non-prepaid orders add $2.50 shipping and handling).
PUB TYPE Guides - Classroom Use - Guides (For Teachers) (052)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Academic Achievement; *Computer Assisted Instruction; *Computer Literacy; Computer Oriented Programs; *Computers; Computer Simulation; Educational Technology; Elementary Secondary Education; Futures (of Society); *Learning Disabilities; Programing Languages; *Underachievement; Word Processing
IDENTIFIERS LOGO Programing Language

ABSTRACT

This booklet is provided as a guide to teachers working with learning disabled (LD) students who are interested in using computers as a teaching tool. The computer is presented as a powerful option to enhance educational opportunities for LD children. The author outlines the three main modes in educational computer use (tutor, tool, and tutee) and shows how the computer meets the LD student's curricular needs in the three modes. The use of a computer with LD students allows the child to experience success in mastering skills while freeing the teacher for other work. Teacher education in computer use is presented as an important key in the development of computer education. The booklet provides a discussion of software and hardware definitions and needs, and equipment selection. A list of references, including magazines, books, organizations, networks, research, and bibliographies, is provided. (MD)

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LEARNING DISABLED STUDENTS AND COMPUTERS: A TEACHER'S GUIDE BOOK

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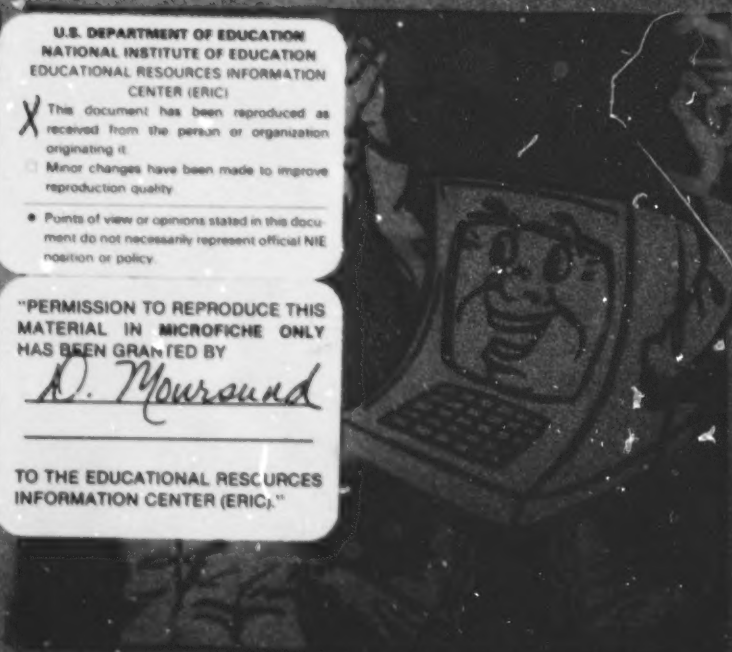

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This booklet was conceived by an interdisciplinary group of computer-using educators working together over the summer of 1981. The authors wish to acknowledge and thank

- Donna Pennell
- Martin Rayala
- Cheryl Sommers
- Katherine Willson

for their research and their first draft of parts of the original document.

Illustrations by Martin Rayala.

The International Council for Computers in Education is a non-profit, tax exempt corporation dedicated to improved instructional use of computers. It publishes *The Computing Teacher,* an international journal that focuses upon instructional uses of computers at the pre-college level.

The booklet prices given below are for ***prepaid*** orders. On other orders a handling and shipping charge will be added.

BOOKLETS

QUANTITY	PRICE (U.S. FUNDS)
1-9 copies	$2.50 each
10-24 copies	$2.25 each
25-49 copies	$2.00 each
50-99 copies	$1.75 each
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"If a school only has two computers, then look for a small pocket of students—perhaps a class of learning disabled youths—and give them the computers."

Seymour Papert

PART I — INTRODUCTION

Teachers continually search for ways to increase their ability to meet student needs. This booklet is for teachers who have had little or no formal training in educational uses of computers but who are interested in using them with learning disabled students.

Most successful L.D. teachers are child-oriented, concerned individuals who believe that the foundation of educational growth and development for L.D. children requires one-to-one and group interaction between students and teacher. Computer-using educators share the concern that computers must not replace the person-to-person relationships that are so critical to the development of a child.

The advent of Public Law 94-142 in the United States has made the job of serving L.D. students even more challenging. Teachers must meet the diverse needs of all students, including the needs of students with recognized learning disabilities. These are students who, by law, now require individualized education plans (IEPs), with a program of study that corresponds to the IEP. The microcomputer is a resource to serve L.D. teachers and students in meeting this additional responsibility.

There are no instant solutions to the enormous tasks which both teachers and students face daily. However, this booklet considers an extraordinary new educational resource for both. A powerful option now exists to enhance a classroom teacher's ability to provide quality educational opportunities for L.D. children.

This booklet is written to de-mystify microcomputers and present them to you as powerful, dependable and efficient aids in meeting the needs of those children legally identified as learning disabled.

The use of computers as an aid in learning disabled education is in its infancy. This means that the teacher of L.D. students who wants to make use of computers will face a number of obstacles. Most hardware is not well designed to fit L.D. needs. Few textbook materials exist to help teachers use computers with L.D. students. Perhaps most important, much of the commercially available computer-oriented curriculum material designed for the learning disabled child:

- Is difficult and time-consuming for teachers to learn to use; the use of such software often does not help to integrate the child into the classroom curriculum but is simply added on.
- Fails to engage students' active interest and participation.
- Is deficient in providing the student opportunities to generalize and/or apply learning skills.
- Is difficult to obtain or is unknown to many L.D. teachers.
- Is difficult to use in a classroom setting without disrupting the students' core curriculum.
- Requires a greater knowledge of computers than most L.D. teachers now have.

All of these problems can be overcome by a determined teacher. The authors of this booklet feel that it will be well worth your while to learn to use computers in L.D. education.

It's a Tough Job

L.D. students are difficult to teach. They are often personally discouraged and are afraid to risk further failure in an academic setting. Often they require a multisensory approach which improves their skill learning by integrating their visual, auditory, kinesthetic and tactile senses. Many also require short, interesting lessons at less difficult reading levels, extra repetitions and immediate feedback. And, like all students, what works for one does not necessarily work for another.

Microcomputers can assist your efforts to meet the needs of learning disabled children by:

- Helping meet the individual needs of children as they acquire skills in reading, writing, arithmetic and problem solving.
- Allowing the child to interact with a well-prepared tutor which provides immediate feedback.
- Serving as a personal tool in the completion of routine academic tasks.

- Providing the child with an environment in which s/he may take charge of the machine, commanding it to perform some activity of interest to the child.
- Providing virtually unlimited time and patience in serving students and teachers as they work toward meeting the goals of each child's IEP.

These capabilities can help you design an effective educational program for the learning disabled child mainstreamed into a classroom, in a resource room or in a self-contained room. And, as the children share newly acquired computer skills with peers, parents and others, they benefit socially as well. They may even gain recognition as a local computer "expert" while developing useful, job-related skills.

What Is a Learning Disability?

While the term "learning disability" is officially defined by P.L. 94-142, teachers don't need a book or a law to help them recognize these children. Teachers describe L.D. children as having at least some of the following characteristics:

- Poor memory. "He'll know things one day, but not the next."
- Seeing and writing words and/or numbers backwards.
- "She can't seem to keep her desk organized."
- Inability to keep the place while reading.
- Reading laboriously.
- Poor coordination.
- Short attention span.

- Acting out.
- Overly active. "He just can't sit still."
- Easily distracted. "The least sound or movement bothers her."
- Unable to follow simple directions.
- Extremely discouraged with school.
- Afraid of failing.

As a teacher, you can probably add to this list. More precisely by law (P.L. 94-142), the learning disabled child is described as having a "Specific Learning Disability." The condition means:

> A disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell or do mathematical calculations. The term includes such conditions as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia and developmental aphasia.

The term does not include children who have learning problems which are primarily the result of visual, auditory or motor handicaps; of mental retardation; of emotional disturbance or of environmental, cultural or economic disadvantage.

The prospect of microcomputers serving elementary teachers and L.D. students is exciting; however, while the microcomputer will help you unlock previously blocked learning potential and make your job more rewarding, it is only one of many educational keys you hold.

This booklet introduces some simple and practical ways to use computers in the education of L.D. students. The question/answer format will allow you to select information most valuable to you.

While this booklet is designed to be self-contained, it does not include everything that an elementary teacher needs to know about computers. An excellent companion booklet is *Teacher's Guide to Computers in the Elementary School* by David Moursund. A still deeper introduction to computers is provided by *Introduction to Computers in Education for Elementary and Middle School Teachers* by David Moursund. Both of these publications are available from ICCE.

"We are at the onset of a major revolution in education, a revolution unparalleled since the invention of the printing press. The computer will be the instrument of the revolution."
Alfred Bork

PART II — THEORY

What Are the Educational Applications of Microcomputers with L.D. Students?

As part of your teacher training, you were probably exposed to many theories of learning. Certainly, educators rarely agree on any one effective way to teach children. The same controversies go on among special educators as they discuss the best techniques for teaching learning disabled students.

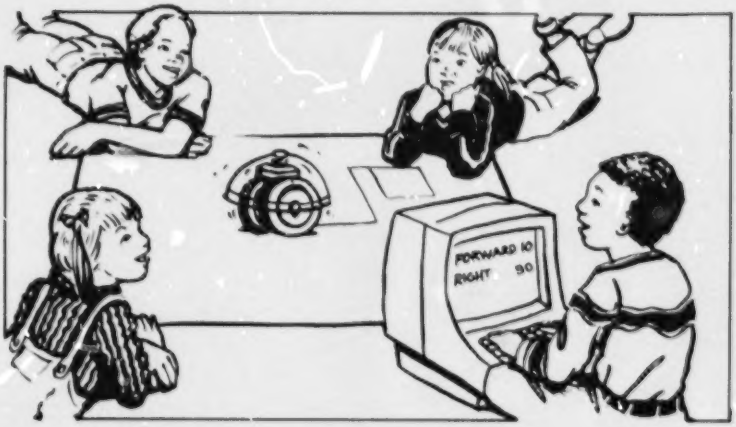
Computers add to, rather than solve, these controversies. Almost any theory of learning that can be implemented by non-computer methods can also be implemented in a computer-assisted mode. As more and better computer-oriented instructional materials become available, this means a teacher will have easier access to a greater variety of instructional modes. The teacher will have to decide which method of learning best fits a particular student's needs.

We will not discuss computer applications via their underlying theories of learning. Instead, we will use a classification scheme developed by computer educator Robert Taylor. In his book, *The Computer in the School: Tutor, Tool, Tutee,* Taylor divides educational computer uses into three main modes:

1. The student may use the computer as a tutor to review and practice material that has already been presented; to learn and practice new information; and to practice solving situational, simulated problems presented by the machine. In this mode the computer is a new type of teacher, a supplement to conventional modes of instruction.

2. The student may use the computer as a tool to do routine tasks such as long division, writing with a word processor, or graphing some data. The computer does the student's bidding through a prewritten program. Students may have access to a program library that has dozens of programs that can help them solve thousands of problems.

3. Students are also in charge in **tutee** mode, but they write programs for the computer instead of selecting a program from a library. Tutee mode involves learning a programming language, something many L.D. students are capable of doing.



The microcomputer can help meet the L.D. student's curricular needs in all three modes by providing:

- Individualization of content and pace.
- Repetition.
- Patience.
- Immediate feedback.
- Motivation (most students are attracted to the machine).
- Consistent presentation and reinforcement.
- Interactive capabilities.
- The ability to elicit a high rate of student response or initiation.
- Systematic review of skills essential for mastery of some aspect of the curriculum.
- The opportunity to develop concepts, to bridge the gap between concrete and abstract ways of thinking.
- A setting to test hypotheses.
- The vehicle for creative, "open-ended" problem solving.
- An environment in which to experiment and be in control.

Whatever your theoretical orientation may be, computers can aid you in reaching your learning disabled students.

"How much longer will a computer illiterate be considered educated? How long will he be employable and for what jobs. . . ."

Arthur Luehrmann

PART III -- CONCERNS & MISCONCEPTIONS

What Are Some Common Concerns and Misconceptions Concerning Learning Disabled Students and Computers?

1. "Learning disabled students don't try; they simply won't make the necessary effort even with constant attention."

The kernel of this observation is that many L.D. students appear lazy or unwilling to try because they will not risk making another mistake. With this type of student, the interactive capabilities of the microcomputer are especially powerful. The student can encounter an individualized, structured, motivating, patient and non-threatening learning environment. The authors have seen an L.D. student (one who actively resisted opening her math book or even writing her name on a math paper) sit totally engaged with educational **software** designed to provide multiplication drill; she worked enthusiastically to master the required tasks for the entire 40-minute period. The student even wrote down troublesome facts to study at home to increase her speed before attempting to repeat the lesson on the following day.

Computer programming offers an especially valuable vehicle to students who don't try through fear of failure. The language Logo, with a task of drawing a simple picture such as a clown face, is an example. The student writes an instruction and immediately sees the effect. If the effect isn't what the student desires, the instruction is easily changed. No messy erasures; no red marks. The feedback comes in a form that invites correction.

Out of simple programming activities emerges the idea of **debugging**—that is, detecting and correcting errors. A program is never "all wrong." It is a standard process in programming to detect and correct errors. A student can learn this concept and carry it over to other, non-programming activities.

2. "Computers should be used by gifted students and not by students who can't keep up with their regular classroom assignments. Using a computer would put them even further behind."

It is a terrible mistake to equate learning disability with level of intelligence. A dyslexic student, for example, may have the intellectual potential and personality to be a poet, politician or university faculty member. The learning disabled student does, however, need extra help at certain stages of his/her academic career.

For many learning disabled students, traditional methods of instruction have not worked. L.D. students *do* fall further and further behind. The teacher and the evaluation team may change this trend by writing an IEP that includes instructional time on a computer in all three modes (tutor, tool and tutee). The use of a computer may well allow the child to become more successful in mastering traditional curriculum as well as in developing the ability to independently formulate and solve problems. The teacher and the evaluation team must set priorities to include schooling most beneficial for the L.D. child. The writing of the IEP gives educators the right and responsibility to teach toward those goals selected and developed by the team.

3. **"As a teacher, I am under a tremendous amount of public pressure to teach all my students successfully. I sometimes feel parents and administrators intimating that I would be more successful if I would only devote a little extra time and effort."**

We laugh to keep from crying. Conscientious teachers are already extended beyond reasonable limits. The inclusion of learning disabled as well as other handicapped children into the regular classroom without extra support and/or resources is unfair to all concerned. Resource rooms, too, are filled to capacity, and the special education teacher is inundated by record keeping, new referrals and the knowledge that it is illegal to keep identified students on a waiting list.

Microcomputers open up several new sources of support for teachers. Software is available that can:

- Maintain convenient and accurate records.
- Test students for mastery of skills.
- Expand practice on skills taught in class.
- Enrich curricular offerings.

Suppose, for example, that a student's IEP calls for work on the single digit addition, subtraction and multiplication facts. The specific goal is to achieve 90% accuracy and complete a mixture of fifteen of these problems in one minute. The student is to be given five minutes of drill each day and tested each week until the goal is achieved six weeks in a row.

This IEP plan can certainly be carried out by a teacher. But it requires careful record keeping, every day drill and every week testing. The entire task is easily handled by a computer, freeing the teacher for other work.

4. **"If they have a place in school at all, microcomputers should drill students on their math and other rote-learning facts."**

Rote learning *is* important, and computers can help with rote-learning tasks. Indeed, most instructional use of computers in elementary school has been for routine drill and practice. But a higher-level goal of education is to help students learn to think and to solve problems using facts and ideas they have memorized. In recent years a wide variety of computer-assisted learning materials have been developed to help students develop these higher-level skills.

For example, there is a computer simulation in which the student plays the role of the ruler of an ancient country. The student makes decisions on how much grain to feed to the people, how much to store, and how much to use in planting. The student must make good decisions or rats will eat the stored grain and people will starve. These decisions are based upon a combination of careful thinking and use of arithmetic to divide up the resources. In this situation, the computer provides a rich and exciting educational environment, highly desirable for all students.

5. **"I do not have sufficient time, aptitude and support services to use computers in my room. Besides, the school doesn't have enough computers to make it worth the effort."**

Many teachers who once felt this way are currently using computers with L.D. students and are extremely enthusiastic. When these computer-using teachers were asked what advice they would give to other special educators who may want to use computers, many responded, "Try it! Don't be afraid of the computer!" (Thormann, 1982) In fact, learning the basics of operating a personal computer takes very little time and does not require extensive training.

It is true that most elementary schools currently have minimal computer facility. But this is changing *very* rapidly. In a few years almost every elementary school will own a number of microcomputers. At the same time, computers are getting easier to use. Every teacher is capable of learning to use a computer as an aid to instruction. A half day of inservice instruction is sufficient to get started.

Once teachers realize their own increased potential using the machine, they often want to learn more than the basics. If teachers sense they don't have the time or aptitude to learn programming or other more technical skills, then there are user groups, other teachers, colleagues, vendors or even interested students to turn to for help with mechanical difficulties and programming tasks. One junior high student (considered a "math genius" by his teacher) learned about a computer in the elementary school and volunteered his time to help L.D. students learn to program. The same junior high now has a waiting list of students who want to help tutor those children with computer time built into their IEPs.

6. **"There is no way we can afford to buy computers under current budgetary constraints."**

Successful education of L.D. students is very labor intensive. Currently, special education teachers working one-to-one with a student might use a computer to provide routine monitoring and reinforcement of skill development, in order for the teacher to use time with students in more crucial areas.

Microcomputers are continuing to decrease in price and increase in capability. This means that the cost-effectiveness of microcomputers is increasing fairly rapidly. Schools *are* purchasing a large number of microcomputers and all predictions are that they will purchase even more in the future.

The essence of the matter is that computers are an important new aid to instruction. Even when budgets are tight, some money can be found for important new projects. Since microcomputers are quite useful to L.D. students and their teachers, many school districts are finding the funds needed to acquire appropriate facilities.

Unfortunately, the focus tends to be mainly on acquiring hardware. Software and teacher education are also essential. (Software is discussed in Section IV of this booklet.)

Teacher education needs to be a combination of formal training and on-the-job experience. We now know that eventually computers will be readily available to all students. One can justify the installation of quite a bit of equipment right now just so teachers can learn on the job. Any such equipment will more than pay for itself if it is used for teacher and for student learning.

7. "At best, computers are a passing fad, a currently fashionable piece of A.V. equipment that will soon end up sitting unused in a closet. At worst, computers are a device for playing arcade-type games—and we certainly don't need such violent games in our schools."

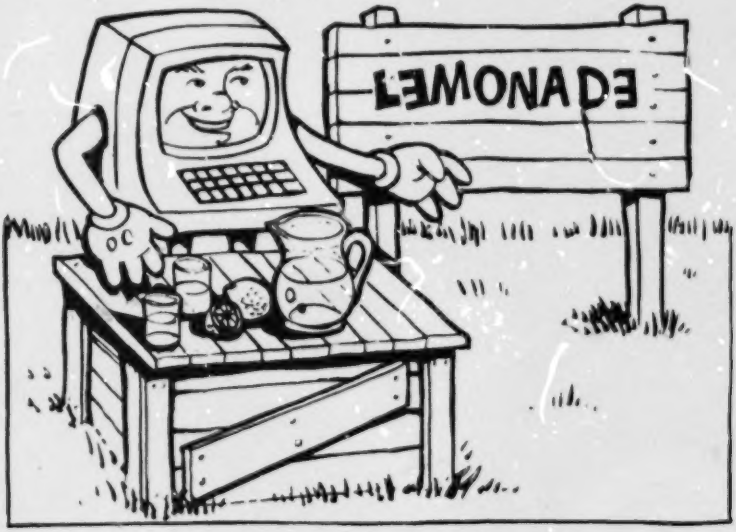
Computers have been commercially available since 1951, and sales continue to increase every year. In business, government, research and industry, computers continue to grow in importance. It is evident that in these applications computers are not a passing fad.

There has been extensive research on the educational use of computers for more than 25 years. There is no longer any doubt about the effectiveness of computers as an aid to education, provided the computer is properly used. This means that the hardware and software must be suited to the educational setting and that teachers need appropriate training and experience. Some computers *are* sitting in school closets—but these are schools that lack appropriately trained teachers.

A school computer can be used to play arcade-type games. But since many educational uses for computers exist, there is little reason to make school computers available for such purposes. School computers should be used primarily for serious educational pursuits.

Of course, computerized instructional material can be made to be both "fun" and educational. Pretending to be the ruler of a country can be fun, and playing such a simulation-game is clearly educational. There are an increasing number of such simulation-

games that are both educational and fun to play. This type of educational software can be an excellent aid to L.D. education.



8. "Computer technology is growing too rapidly--there is no way teachers can keep up with this technology, and it can't help but be misused."

There is no doubt that computer technology and computer applications are growing rapidly. One can take the "head buried in the sand" approach, but neither the promising nor dangerous potentials of computers will go away.

To understand this problem, one needs to understand the nature of possible educational misuses of computers. Imagine a teacher that has an L.D. student who tends to disrupt the class. The teacher places the student alone in a corner with a microcomputer and a supply of games. The student is isolated, entertained and is no longer disruptive. This is an educational crime.

For a second example, picture a teacher that has an L.D. student who is weak on number facts. The teacher has the student use a drill and practice program for the entire arithmetic period each day. The student gets neither practice nor instruction in developing higher level problem-solving skills. In addition, interaction with the teacher is minimal, and opportunities for social and academic skill development with other students is severely limited. This, too, is a misuse of computers in education.

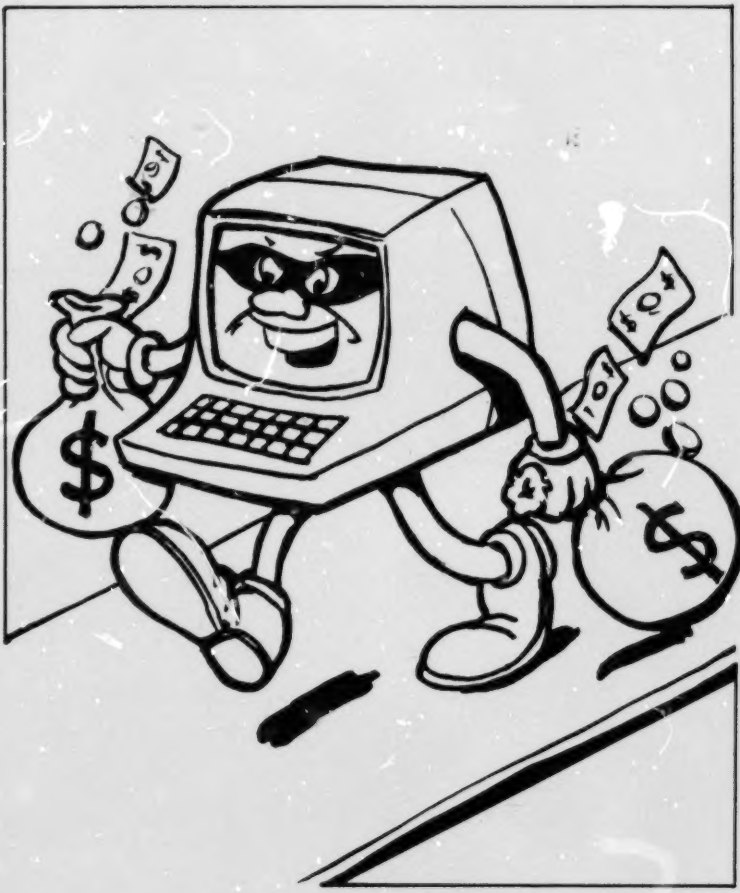
These types of mis-applications can be avoided as concerned teachers and administrators become involved in educational computing. It is not necesary for computers to be a dehumanizing or anti-social force in education.

The key, once again, is teacher education. While the technology and availability of computers are growing rapidly, the basic underlying principles are now well known. A computer can rapidly and accurately carry out a detailed step-by-step set of instructions that has been prepared by a person. This set of directions may make use of large data banks of information and may involve extensive interaction with people, measuring instruments and other machines. The step-by-step set of instructions may be designed to solve or help solve problems from any academic discipline, including the discipline of teaching/learning. All teachers can learn the general capabilities, limitations, applications and effects of computers. These general ideas change only slowly; once a teacher understands them, the teacher has little trouble adjusting to the continuing changes.

9. "Encouraging the use of computers in schools may cost me my job."

Those familiar with educational uses of microcomputers recognize that this is not likely. The human element is essential in fostering student growth. Instead of replacing the teacher, computers can help teachers individualize instruction for their learn-

ing disabled students, thus leaving more time in the day for teacher interaction with every child in the class. Computers do what computers do best—aid those who know how to put them to work. Teachers will continue to do what they do best—create an educational environment that fosters the academic and social growth of students with many different needs and abilities.



The guidance and support teachers provide for L.D. students now, while in elementary school, will shape the rest of their school careers, as well as influencing their ability to build satisfying and productive lives for themselves. A literate and employable adult

in the twenty-first century will probably know how to use computer technology in ways we can only begin to imagine. If today's learning disabled students are to stand among those literate and employable young adults in the year 2000, then we need to provide them the best possible education today. Learning *about* computers and learning *using* computers are important in achieving that goal.

"Evaluators of software must know what computers are capable of providing if they are to avoid using the new technology in the same manner as the old."

Jay W. Dean

PART IV — SOFTWARE

What Is Software, Documentation and Courseware?

Software is to a computer much as a record is to a record player or a film is to a film projector. Software "gives life" to the computer by transferring a list of instructions into the computer's memory. These instructions, or programs, are written in a language that the machine can decode. They are stored on magnetic tapes, magnetic disks or plug-in cartridges.

A computer program may contain detailed instructions on its use. But usually it is necessary to provide the user with a computer program with some additional print and/or non-print materials. A computer program to be used by students may need a teacher's guide, a student resource manual and perhaps a list of related audiovisual materials. **Courseware** is a term for educational computer software with its supporting student and teacher materials.

Every well-written piece of courseware is accompanied by adequate technical **documentation.** This written material is primarily of value to programmers and others interested in the technical specifications and characteristics of the software. Such documentation is essential if the program is to be modified, to correct errors and/or to change its performance.

A high-quality piece of educational software will be accompanied by appropriate student and teacher materials and adequate documentation. Relatively little of the educational software currently being used meets those criteria. This is slowly changing, as vendors strive to meet the demands of the educational computing market.

How Do I Run a Program?

Running a program (that someone else has written) is about as difficult as using a stereo system. A few minutes of instruction and practice are required. Young children learn to do it. The first steps in using a typical microcomputer are:

1. Select a program from a library of programs. The library may be on magnetic tapes, magnetic disks, or plug-in cartridges.
2. Turn on the computer system. Often different components, such as the TV-like display screen or the printer, have separate on/off switches.
3. Load the program you have selected into the computer's primary memory. Details on how to do this vary with the computer system being used.
4. Run the program and interact with it.

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All this is really quite simple. However, like anything mechanical, computers occasionally malfunction. Additional training and experience are needed to deal with exceptional cases. In the absence of this extra training and experience, remember to take these steps in case of trouble:

1. First check that everything is plugged in and turned on.
2. Read the instructions accompanying the software.
3. Start over from the beginning.
4. Read the computer manual.
5. Experiment; you are unlikely to damage the computer by a little trial and error.
6. Seek help from other computer users. (There may be a student in your class who knows more about computers than you do.)

The key idea is that many millions of people have learned to use computers—**you can too.**

How Is Software for L.D. Students Designed and Developed?

After a few minutes of instruction, a beginning computer programmer may be able to write a very short but useful program. At the other end of the spectrum, professional programmers are apt to have many thousands of hours of training and experience behind them as they work for months or even years to develop effective programs.

The development of professional quality educational software for learning disabled students is a difficult, costly and time-consuming task. Knowledge and skills may be required in the following areas.

- Special needs of learning disabled students.
- Curriculum content.
- Curriculum design.
- Learning theory.
- Computer science/computer programming.
- Educational media.

Seldom does one person have such a range of expertise, so teams of people are often involved in the overall task of research and development.

The software developer or development team faces two important challenges. The first is to be familiar enough with effective curriculum for L.D. students to be able to design a good inter-

active environment for the student. This environment must be designed to involve and respond to the L.D. student with a satisfying learning situation that avoids the negative aspects of previous learning experiences or settings. Skill levels, vocabulary and pacing must all be designed to accommodate students with a wide range of abilities. One major goal is to help overcome a student's fears. The child is then able to attend more fully to the learning experience.

The second challenge facing writers of educational software is to write a computer program that implements the design. This is no small task. Even one minute of interactive computer time may call into play a list of machine commands thousands of lines long. This helps to explain the modest amount of high-quality educational software currently developed and available.

What Role Can I Play in Software Design or Development?

Some educational software is designed so that teachers can easily modify its instructional content. Vocabulary words can be changed. Topics on which to be drilled, as well as the degree of difficulty of the drill, can be adjusted by the teacher.

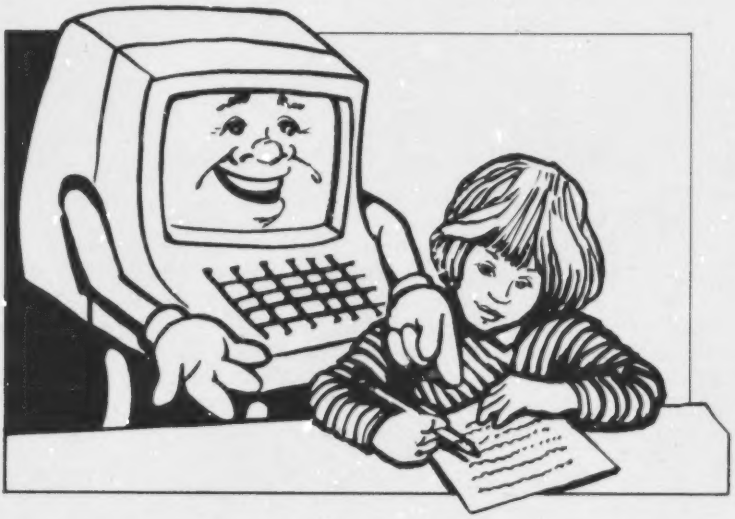
Other educational software is designed so that a teacher can use it to create instructional sequences. The programming language PILOT is an example. With a few hours of instruction in PILOT, you can learn to write simple instructional materials. Even a very simple program can be useful if it is especially designed to fit the learning needs of a specific student.

You may also be part of a group whose goal is to design effective educational software. Teachers have considerable knowledge of learning disabled students, curriculum content and educational media. These qualities make teachers valuable members of software development teams. Of course, all members of such a team benefit from having a reasonable level of computer knowledge—especially an awareness of the capabilities and limitations of computers.

Programming is time-consuming and the resulting program is often imperfect. However, a home-grown program will probably work because its author knows the problem, the students and the capabilities and limitations of the program. Teachers can promote software development by publicizing good programs and by resisting the temptation to make or receive unauthorized copies of courseware. Adequate amounts of high-quality software will never be available unless developers are adequately compensated.

How Can I Make Sense of the Wide Variety of Educational Software?

As briefly outlined in Part II, Robert Taylor divides educational software into three major categories which he labels *tutor, tool* and *tutee*. Currently, most computer use with L.D. students fall into the tutor category. All three categories, however, offer excellent instructional opportunities.



The Computer as a Tutor

The tutor mode of educational computer usage includes:

a. Drill and practice
b. Programmed instruction
c. Educational simulations
d. Simulation-games

Drill and Practice

If an L.D. student finds mastery of a specific skill difficult, the teacher can provide drill and practice exercises, designed to supply the extra repetitions and immediate corrective feedback that may help the student master the skill.

For example, a drill and practice program may present children with questions about dividing different words into syllables. Some drill and practice programs are quite sophisticated, allowing random presentation of problems, record keeping of student

responses, variable speed of presentation, adjustable levels of difficulty and diagnostic analysis of errors.

Programmed Instruction

Programmed Instruction (PI) is often appropriate for the L.D. student because it presents new information in small, sequential units and asks questions about the information. Based on a student's response, the computer chooses the next appropriate frame or level. Programmed instruction is designed to shape student responses. It provides the framework for the student to master a new skill or concept without experiencing undue frustration or making and practicing errors. Error-free learning can be important for building confidence in an L.D. student who has previously experienced a great deal of failure.

Educational Simulation

An educational computer simulation presents key aspects of some problem situation and is designed to help students learn about the problem area. For example, one can easily simulate the process of going to a store, selecting some items to be purchased, paying for the items and getting change. The student may be involved in selecting the "best buys," adding up the total cost and figuring out the correct change.

Simulations can be designed to approximate problems found in daily life or to provide problem-solving practice with situations that are too dangerous, too expensive or impossible for the L.D. student to try first hand. An educational simulation allows the student to make decisions in areas such as money, science, history, life goals, health and safety. After students enter their decision into the computer, they are presented with computer-estimated consequences of that decision.

The natural and social sciences lend themselves well to this type of problem solving. Students are able to simulate dangerous experiments or phenomena such as war, population growth or a pilot's view of landing an airplane. For L.D. students, these simulations offer the opportunity to experience control in an academic setting, to use and develop logical problem-solving strategies and to find themselves responsible for discovering a solution and achieving success.

Simulation-games

Simulation-games are computer simulations with gaming or entertainment features. A simulation may involve a student answering questions and making decisions. If the simulation keeps score and allows the student to try to get a higher and higher

score, it is a simulation-game.

Simulation-games have proven to be an excellent aid to education. The student is put into a challenging but entertaining environment, sometimes with an adventure or fantasy theme, involving learning by doing. Students can become deeply engrossed in such simulation-games, just as they become engrossed in arcade games. Simulation-games are quite appropriate to almost every educational setting and may be especially useful with L.D. students. There the success of scoring, the experience of competing against oneself and of succeeding at a higher level with increased practice and knowledge are powerful aids to learning and to self-image building.

The Computer as a Tool

Technology can circumvent some of a learning disabled student's disabilities by enabling the student to direct the computer to manipulate numbers and letters. An everyday example of the computer as a tool is a pocket calculator. With this tool, L.D. students who are able to understand basic math concepts but are unable to do error-free calculations due to poor memory, visual perception problems or other problems of access are able to perform at a higher level in math.

Typically, an L.D. student's written work is difficult to read. Both teacher and student are often unsatisfied with the content and appearance of the student's papers. Use of a **word processor,** a computerized typewriter, can bypass some writing problems by

presenting students with an aid for editing and recopying their work. In the process, some traditional frustrations experienced by L.D. students may disappear. No more crumpled papers, spacing errors or reversed or poorly formed letters. Mistakes, once recognized, can be cleanly and easily edited. Imagine the L.D. student's joy in being able to write and hand in papers that are neat in appearance! The time and energy previously spent on the laborious recopying of rough drafts can now be spent in developing ideas.

Of course, a word processor is not just a tool for students. A word processor is an excellent aid to teachers, especially those who have to do a lot of report writing. Word processing systems are quite useful in creating and maintaining IEPs.

Another exciting example of the computer as a tool is in music composition and performance. Many computer systems contain a music synthesizer and a "language" for keying in and editing music. The computer can automatically play the music that is keyed in. This allows a student with poor or no musical performance skills to compose music and hear it performed. Students provide feedback for themselves, modifying the composition until it is pleasing to their ears. Imagine how an L.D. student would feel about creating an original musical composition and having the computer play it for the whole class!

The Computer as Tutee

In the tutee mode, the students become tutors, instructing the computer (tutee) to follow directions. As students explore the simplified elements of a high level programming language, they

learn to conceptualize and write programs to accomplish various tasks that students themselves set. The student learns a programming language and then writes programs to accomplish various tasks.

The programming language Logo was developed by Seymour Papert and others at the Massachusetts Institute of Technology. Logo was especially designed for young children and has been extensively tested in a variety of elementary school settings. One important aspect of Logo is "turtle" geometry. Under student and computer control, a small object, called a turtle, is directed to move about the computer display screen. (Robot turtles that move on the floor are also available.) The student directs the turtle to draw pictures such as a clown, a flower, a house, etc., depending on the student's developing interests and skills.

Logo is an excellent programming language for children. It helps students learn the idea of a detailed set of directions, of program testing and of debugging as it provides L.D. students the chance to pose and solve problems of their own design. In addition, the format meets many of the following needs of L.D. students:

- Self-pacing.
- Appropriate and immediate feedback.
- Motivation.
- Repetition and consistency.
- Opportunity for the child to explore many ways of solving a single problem.
- Opportunity for self-evaluation.
- A setting in which students are challenged to learn to identify and correct their own bugs (or misdirections) in order to get the desired response.
- An environment where success does not depend entirely on reading ability.

How Do I Evaluate Software?

Software that is appropriate to use with L.D. students must meet general criteria for software that is appropriate for any student, as well as additional criteria that addresses an L.D. student's special needs. Good software is based on sound instructional theory and assists students in meeting clear educational objectives.

Before purchasing software for L.D. students, it is advisable to try it out with them to determine whether it meets their needs.

Many software vendors now have a 30-day, money-back guarantee. Also, larger cities now have stores that carry a variety of software which can be tried out in the store. You may be able to borrow software from your school district or from some other school in order to test it.

In any event, it makes little sense to purchase educational software sight unseen. If you must do so, take advantage of the various software review publications that now exist. The reference section provides several excellent sources of reviews.

Here is a list of general considerations to keep in mind when evaluating L.D. software:

- The directions for the student should be clear and at an appropriate level.
- The reading level throughout should be appropriate and consistent for the task and the student.
- The program should reflect the age and interest level of the student.
- The time it takes the student to complete the program must fit the teacher's plan of instruction.
- Minimal teacher supervision should be required.
- The student response rate should be high. Thus, the program should make full use of the interactive capabilities of the computer.
- Skills learned or practiced on the computer should relate in some way to the student's instructional program.

- Graphics should be integrated and should actually support the instructional goals of the program.
- Prompts or hints should be provided only when needed.
- Criteria for mastery should be clear and consistent. Software does exist that allows the teacher to set the appropriate mastery level for each individual, and the computer will only allow the student to advance to a different level after the set criteria has been reached.
- Feedback for responses, both correct and incorrect, should be appropriate. For example, repetitive congratulations become boring, while some well-meant, "encouraging" feedback to incorrect responses can be so interesting to students that they will respond incorrectly in order to see and hear it.
- The number of inappropriate student responses allowed by the program should be limited.
- It is especially important that L.D. children use programs that allow them to exit easily, save what has been done and return to the program at a later time. This is especially important, not only for students with short attention spans, but also to help respond to resource room schedules.
- The program should match students' skill levels and needs. Students should have the prerequisite skills required by the program.

Where Do I Obtain Educational Software?

Sources of educational software fall into three general categories:

1. Companies and individuals that develop and/or market software. There are now many hundreds of companies, large and small, that market educational software. The larger ones tend to advertise extensively in national magazines and educational journals. A few companies that market L.D.-oriented software are listed in the reference section of this booklet.
2. Professional organizations and private individuals who provide inexpensive or free access to "public domain" software. The Computer-Using Educators SOFTSWAP in California maintains a library of hundreds of programs for a variety of microcomputers. Such free or inexpensive software may be poorly documented and lack supporting materials for students and teachers.

3. Computer manufacturers who develop software and also market software developed by others. If you are involved in the acquisition of a microcomputer, your decision might be made on the basis of what software the manufacturer or vendor will supply or has available.

In all three sources, relatively little attention has been paid to the special needs of L.D. students. L.D. students can make use of some of the software developed for non-L.D. students, but it is important that first you thoroughly review the software with their needs in mind.

When looking for educational software, check with other teachers who are making educational use of computers. Word-of-mouth recommendations can be very useful, since they are often more honest and down-to-earth than nationally published reviews.

". . . suppose for a moment that the automobile industry had developed at the same rate as computers and over the same period: how much cheaper and more efficient would the current models be? If you have not already heard, the analogy is shattering. Today you would be able to buy a Rolls-Royce for $2.75, it would do three million miles to the gallon and it would deliver enough power to drive the Queen Elizabeth II."
Christopher Evans

PART V — HARDWARE

What Is Hardware?

The physical pieces of a computer system (excluding printer paper, disks and tape) are called **hardware**. The major visible components of computer hardware include:

1. **Input units.**
   These pieces of machinery convert information from outside the computer into electrical impulses the computer can use or store.
2. **Output units.**
   These machines convert information from inside the computer into print, visual images, sound or other useful forms outside the computer.
3. **Secondary storage.**
   These are tapes and tape drives or disks and disk drives. Software is stored on tapes or disks.

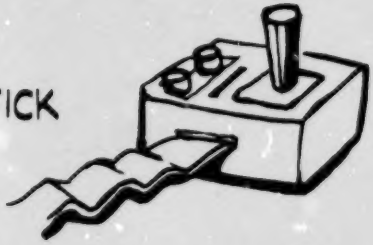
The major components not visible from outside the machine are:

4. **Primary storage** and
5. **Central Processing Unit (CPU).**
   These are the electronic components inside the computer that store a program and carry out its instructions. Generally speaking, the size of a computer's memory controls the length and sophistication of programs it can store and run.

A hand-held microcomputer may cost as little as $150, while a top-of-the-line microcomputer system can easily cost $10,000 or more. The microcomputer market is now quite competitive, and a wide variety of hardware is available from a number of manufacturers. This generally means that there is no one "best buy."

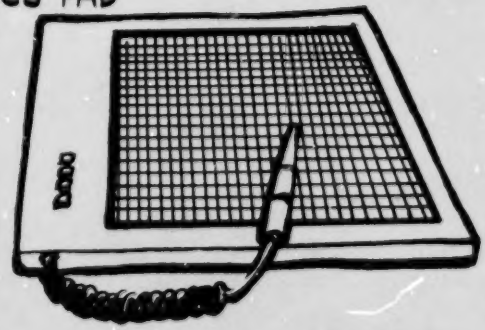
Input

KEYBOARD



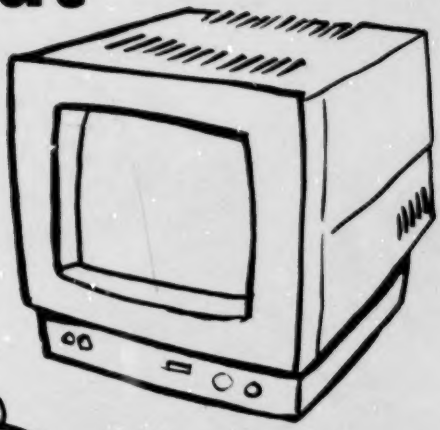
JOYSTICK

GRAPHICS PAD

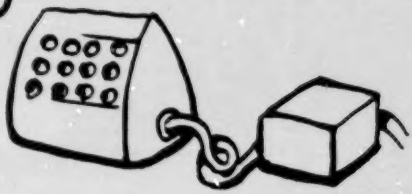


Output

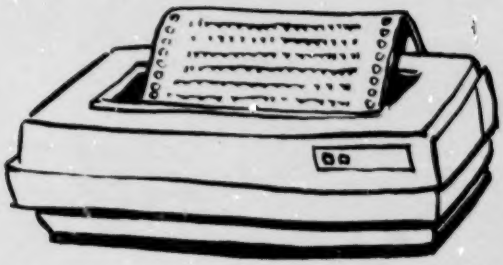
MONITOR



VOICE SYNTHESIZER



PRINTER



Secondary storage

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What is most appropriate to the needs of one school or set of students may not be best for a different setting. As prices change (they're dropping) and new pieces of equipment are marketed, the purchaser faces a wide range of choices.

How Do I Choose an Appropriate Computer System for My L.D. Students?

Ideally, someone who knows the field of computers-in-education and who is well versed in the needs of L.D. students would help you. The overall process of selecting and acquiring a computer system is a complex one.

More likely, however, one of two situations will occur. If your school or district already owns computer equipment, it may have a policy that all new hardware must be the same make/model, so that software can be shared. In this case your only decision is "to use or not to use."

Alternatively, you may have to make such a decision by yourself or with minimal help from others. There are two important considerations:

- Consider your goals. Decide why and how you want to use a computer and what the computer can help you accomplish.
- Look for software/hardware combinations suited to your goals. Usually software will be the key issue. Your acquisition decision should be based on finding a computer system that can utilize the software that comes closest to meeting your needs. It is generally a mistake to let hardware be the most important factor in the overall acquisition process.

While looking for appropriate software/hardware combinations, find other teachers who are already using computers to accomplish goals similar to yours. By meeting with these teachers, you will gain from their expertise and insights. In most cases they will inspire you and provide you with practical support that few sales representatives or commercial demonstrations can match.

The technology of computers continues to change at a breathtaking pace. Each company producing microcomputer systems for educational uses is working to make computers more capable, more reliable and easier to use. Rapid progress will continue for the next twenty years or more. But today's equipment is quite good—well worth its cost. If this equipment fits the needs of your L.D. students, it is important that you work to acquire the equipment and learn to use it.

"I hear and I forget.
I see and I remember.
I do and I understand."
—Proverb

PART VI — THE PROMISE

What might educational computing do for a learning disabled student in the future?

In short, educational computing may offer a new context in which learning disabled students begin to do the kinds of listening, thinking, speaking, reading, writing, mathematical calculation and problem solving that schools uniformly require of their students. No teacher, and certainly no machine, can *make* a student learn to do these things well. What educators and educational computing may do very well over the next generation, however, is to provide L.D. students with the individualized kinds of challenges and possibilities that draw heavily on students' existing, perhaps untapped, educational abilities, while allowing for their particular disabilities. These computer-delivered challenges and possibilities could be educationally rich and exciting from both a student's and teacher's point of view, especially if educators, psychologists, engineers and computer scientists work together to develop and refine programs and materials for learning disabled students.

Imagine if you will this scenario unfolding for a young L.D. student in your district:

One fall in the 1980s, an active, energetic 7-year-old named John entered first grade. After a discouraging school year for John, his parents and his teachers, he was diagnosed as learning disabled. Fortunately, an individualized education plan was then designed to help John's teachers meet his special needs—an IEP which included ready access to one of the school's new microcomputers.

John's classroom teachers worked with special educators to schedule and manage his time both in and out of the regular classroom. Their personal instruction and attention to his special needs as well as their support in helping him with appropriate microcomputing courseware began to pay off. John found he *could* succeed in school. His successes built one upon another. As he worked to learn to read, write and do arithmetic, he also began to use computers as handily as earlier generations of school children used pencils and paper.

During his elementary school years, both John and educational computing made remarkable gains. Instead of the first grader who found school frustrating and unrewarding, John began to develop into an autonomous, questioning, self-directed learner. He trusted his abilities and worked to increase them. He actively pursued interests at school, learning to work on his own as well as with teachers and peers.

Microcomputer tutoring accounted for roughly one-third of the time he used the computer in school. He used other kinds of software to write and revise drafts of his assigned papers, then to print clean, final copies of them. He also enjoyed using words and numbers to command Logo's turtles and sprites to create geometrically-defined shapes and movements on the screen. He became adept at debugging his directions when these shapes or animated creatures looked or behaved differently than he expected.

By the time John reached middle school, personal computers were shrinking dramatically in both size and cost while outperforming the big, old, typewriter-like models of the past. Inexpensive, voice-controlled and "speaking" book-sized microcomputers functioned independently in the hands of their users or connected easily to larger systems. Library/media centers were changing, too. In addition to books, periodicals and audio-visual materials, increasing amounts of electronically accessible software, videodisks and resource information were also indexed and available for the user's convenience.

During his first year at middle school, John learned to locate these resources using a microcomputer connected to the media center system. In biology class John decided to do a term project on the environment and life-cycle of the Tyrannosaurus Rex. He began by combing the resources of his media center, electronically.

JOHN: (book sized computer in front of him)
"Get ready, computer."

COMPUTER: "Ready, John."

JOHN: "Let's do a search."

COMPUTER: "A media center index search?"

JOHN: "Yes."

COMPUTER: "OK, John. What general topic do you wish to search?"

JOHN: "Tyrannosaurus Rex."

COMPUTER: "Is that a large carnivorous dinosaur of the Cretaceous period?"

JOHN: "Yes."

COMPUTER: (slight pause) "There are 57 references to Tyrannosaurus Rex or Tyrannosaur in the index. Look at your screen to see the 10 resource categories you can choose from."

1. Periodicals
2. Encyclopedias
3. Non-fiction books
4. Fiction books
5. Films, filmstrips and slides
6. Talking book video disk systems
7. Tutorial software and courseware
8. PBS and other network television listings
9. Museum exhibitions and catalogs
10. Community resource people under the heading "Prehistoric Life."

COMPUTER: "Select the resource categories you want to explore by saying the number to the left of each one."

JOHN: "2, 3, 5, 8, 9, 10."

COMPUTER: "OK. Would you like citations for these sources copied to your file under 'Tyrannosaurus Rex'?"

JOHN: "Yes."

COMPUTER: "Done."

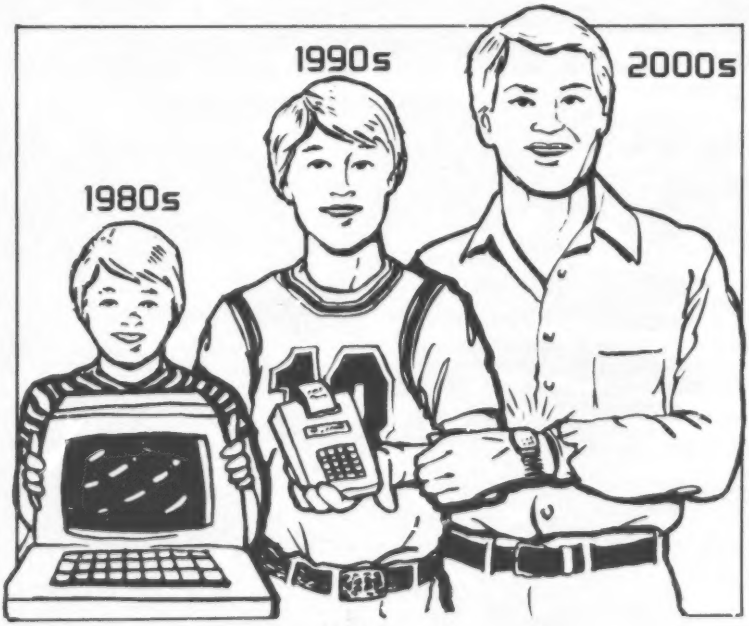
As John surveyed and browsed through the resources of his school library/media center, both in person and via microcomputer, he found there was more information than he could easily organize himself. He asked the school's media specialist and his biology teacher for assistance in outlining his project. Each suggested especially worthwhile citations from his original search list. He also met regularly with his biology teacher to discuss his progress and goals.

Another highlight of John's middle school experience was learning to use electronic mail. His social studies teacher initiated a "computer pal" program that set up letter writing between John and foreign students his age. As John wrote and received electronically conveyed messages (with delivery time

counted in minutes or hours, not days or weeks), both his writing skills and his interest in social studies issues improved markedly. With international telephone and videophone rates beyond the means of public school budgets, satellite-relayed electronic mail cost less than surface mail rate for letters on paper.

Just out of high school, John wore his family's graduation gift —a personal computer—on his wrist. He had used computers routinely in his high school classes, as did his teachers. Thanks to the educationally appropriate use of computers, teachers were able to give more of their time to small group discussions. Together, they provided opportunities to discuss subjects at a greater depth and interacted with students more directly and personally than traditional lecture-type classes. Computers took over much of the work for teachers in recordkeeping, management of students' skill acquisition and in both diagnostic testing and testing for levels of competency.

By the turn of the century, computer impact on industrialized society and its workplaces included a system of public education that extended far beyond high school. John spent his late teens and early twenties working in the Public Service Corps and later at part-time jobs while continuing his education.



Then, in what started as computer play, John invented a way to display computer graphics on specially treated shirts. He designed and programmed a way to make these shirts display colorful and changing reproductions of famous paintings, authentic-looking leopard spots, or even a weave of rainbow colors tuned to the wearer's heartbeat, respiration and other vital signs. This invention caught the public's eye and grew into a successful business. Once labeled learning disabled, John now knew he could learn practically anything he set out to learn, and was able to reach personal goals while contributing significantly to society.

Today's promise of educational computing for learning disabled students is itself challenging and full of enticing possibilities. In order to develop, however, the field needs the full participation of people who work daily with L.D. students.

Your use of microcomputers now and your development of the promise of educational computing will help insure that your L.D. students develop the skills, knowledge and attitudes they will need to participate fully in tomorrow's society.

PART VII — REFERENCES

Magazines

Bounty, published by Joanne Doell, 17710 Dewitt Ave., Morgan Hill, CA 95037. ($6. for 4 issues/yr.)

This quarterly contains articles about language and learning disabled students. It also has a section entitled "Computer Corner" with reviews of special education software.

The Catalyst, published by the Western Center for Microcomputers in Special Education, 1259 El Camino Real, Suite 275, Menlo Park, CA 94025. ($12. for 6 issues/yr.; $20. for institutions, agencies and schools)

This newsletter features articles about use of microcomputers in special education, including topics such as finding and selecting software, financing purchase of equipment and current issues in special education.

Classroom Computer News, 51 Spring St., Watertown, MA 02172. ($12. for 6 issues/yr.)

Features short articles aimed at classroom teachers and school administrators at the precollege level.

Closing the Gap, Rte. 2, Box 39, Henderson, MN 56044. ($15. for 6 issues/yr.)

This bi-monthly newsletter is specifically written for parents and educators to inform them how computers can assist handicapped individuals.

The Computing Teacher, 135 Education, University of Oregon, Eugene, OR 97403. ($16.50 U.S.; $20. Non-U.S. for 9 issues/yr.)

The Computing Teacher, journal for ICCE, is designed for precollege teachers interested in the instructional use of computers. It contains material of immediate classroom use including regular columns, activities, software reviews, book reviews and an index.

Electronic Learning, 902 Sylvan Ave., Englewood Cliffs, NJ 07632. ($17.50 for bi-monthly September-May)

Published by Scholastic, Inc., *Electronic Learning* is aimed at beginning users of calculators, computers and other electronic aids to learning.

Journal of Learning Disabilities, Editor-in-Chief Gerald M. Senf, 1331 E. Thunderhead Drive, Tucson, AZ 85718. ($32. for 10 issues/yr.)

This journal features articles on microcomputer-based applications for learning disabled children. It includes a section called "Computers in the Schools" and courseware reviews with each issue.

Popular Computing: BYTE Publishing Co., P.O. Box 397, Hancock, NH 03449. (US: $15 for 12 issues.)

Popular Computing, useful for new or soon-to-be computer owners or users, contains detailed information and general coverage of issues.

Books

Learning with Logo by Daniel Watt. BYTE/McGraw-Hill, 1983, $14.95.

A book for kids and adults to use together. *Learning with Logo* is part of a series which will cover authentic versions of Logo.

Mindstorms: Children, Computers and Powerful Ideas by Seymour Papert. New York: Basic Books, 1980. ($12.95)

This book presents a forward-looking view of computer use in education; the computer language Logo is described in detail. Although information does not pertain directly to special education, many of the ideas can be effectively used with special education students.

Special Technology for Special Children: Computers to serve communication and autonomy in the education of handicapped children by E. Paul Goldenberg. University Park Press, 233 East Redwood St., Baltimore, MD 21202, 1979. ($14.95)

Goldenberg's book describes the use of Logo with cerebral palsied, deaf and autistic students as well as an innovative view of computer use in special education.

The Computer in the School: Tutor, Tool, Tutee. Ed. by Robert P. Taylor. Teachers College Press, 1234 Amsterdam Ave., New York, NY 10027. ($14.95)

Taylor's book first presents a framework for thinking about three kinds or types of computer application from the student's point of view: the computer as the student's tutor, as the student's tool and as the student's own student or tutee. He then presents collected essays of six prominent pioneers in the field of

computers in education, letting their voices present and perhaps persuade the reader of the educational value of each application.

Organizations

CEC (Council for Exceptional Children), 1920 Association Dr., Reston, VA 22091.

CEC acts as a clearinghouse for information on the needs of exceptional children, including learning disabled children. CEC also sponsors conferences addressing these needs.

ICCE (International Council for Computers in Education), 135 Education, University of Oregon, Eugene, OR 97403. (503) 686-4414.

ICCE is a professional, non-profit organization for people interested in instructional computing at the precollege level. It has more than 10,000 Individual Members and 31 Organization Members made up of regional, state- or province-wide and special-interest groups. ICCE publishes a number of booklets of interest to computer-using educators as well as *The Computing Teacher* magazine.

MECC (Minnesota Educational Computing Consortium), 2520 Broadway Dr., St. Paul, MN 55113. (612) 376-1101.

MECC provides services for students, teachers and administrators in Minnesota public schools and colleges. MECC offers in-service training and curriculum guides, develops and distributes educational software and is a source of software and written materials for Apple II and Atari. (Contact MECC for charges to nonresidents of Minnesota.)

TERC (Technical Education Research Centers, Inc.), 8 Eliot St., Cambridge, MA 02138. (617) 547-3890.

TERC provides information about computer use for both regular and special education teachers. A clearinghouse about computer use in special education is being established and workshops on computer use in special education are offered by TERC. A resource list concerning computer use in special education is available, as well as *Hands On*, a free newsletter.

Networks

This developing resource involves the use of computers linked to a central information exchange, and provides the opportunity for subscribers to acquire and share information about special education. Two current networks are:

- SpecialNET (Special Education Community Network), National Association of State Directors of Special Education, 1201

16th St., N.W., Suite 404E, Washington, DC 20036. (202) 833-4218.

- HEX (The Handicapped Educational Exchange), Richard Barth, 11523 Charleton Drive, Silver Springs, MD 20902. (301) 681-7372.

Research

Research concerning computer use in special education is occurring at many universities. A few universities and names of researchers are listed here:

- Michigan State University, Artificial Language Laboratory, Computer Science Department, Michigan State University, East Lansing, MI 48824.
- University of Louisville, Dr. Emerson Foulke, Psychology Department, University of Louisville, Louisville, KY 40208.
- University of Washington, Dr. Wesley Wilson, University of Washington, Seattle, WA 98195.
- University of Wisconsin, Gregg Vanderheim, TRACE Center, 314 Waisman Center, University of Wisconsin, 1500 Highland Ave., Madison WI 53706.
- Utah State University, Kim Allard, UMC-68, Utah State University, Logan, UT 84322.

Bibliographies

Computers for the Handicapped in Special Education and Rehabilitation: A Resource Guide. Rehabilitation Research and Training Center, University of Oregon, 1982. Available from ICCE, 135 Education, University of Oregon, Eugene, OR 97403, (503) 686-4414.

Includes more than 180 annotated citations from over 39 journals, over half dated since 1980. The entries focus on computer assisted instruction in both an educational and client setting and computer managed instruction.

The International Council for Computers in Education

135 Education
University of Oregon
Eugene, Oregon 97403
(503) 686-4414

IF YOU **Teach about computers**
Teach using computers
Teach teachers about computers

THEN **ICCE works for you!**

ICCE provides a way for educators to further instructional computing. Many statewide, regional and special-interest organizations have joined ICCE in this effort. Members of all these organizations are dedicated to the effective and proper use of computers in education.

ICCE Organization Members

Alaska Association for Computers in Education (AACE)
Contact: Kathleen L. Castle, Adult Education Coordinator, The Northern Institute
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Alberta Association for Educational Data Systems
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Association for the Development of Computer-Based Instructional Systems (ADCIS)
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Bellingham, WA 98225

Computer Education Society of Ireland
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85 Limetrees Road East
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Computers, Learners, Users, Educators Association (CLUES)
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50 Nellis Drive, Wayne, NJ 07470

Computer-Using Educators (California)
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Computer-Using Educators of British Columbia (CUEBC)
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Educational Computing Organization of Ontario (ECOO)
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Toronto, Ontario, Canada M5S 1V6

Educational Microcomputer Users Group of Central New York (EMUGCNY)
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Roxboro Middle School, Mattydale, NY 13211

Educators Interest Group of the San Diego Computer Society
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Florida Association of Science Teachers (FAST)
Contact: Carol Collins, President
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Idaho Computer Educators Association (ICEA)
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8th Avenue and 6th Street, Lewiston, ID 83501

Illinois Association for Educational Data Systems (ILAEDS)
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Indiana Computer Educators
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Manitoba Association for Educational Data Systems (MAN-AEDS)
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Michigan Association for Computer Users in Learning (MACUL)
Contact: Lary R. Smith, Communications Sect.
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Minnesota Association for Educational Data Systems
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New Hampshire Association for Computer Education Statewide (NHACES)
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Durham, NH 03824

Northwest Council for Computer Education (Oregon, Washington and Northern Idaho)
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La Grande, OR 97850

Oklahoma Educational Computer Users Program (OECUP)
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Pennsylvania Learning Resources Association (PLRA)
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Texas Computer Education Association
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Wyoming Educational Computing Council
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Young People's LOGO Association (YPLA)
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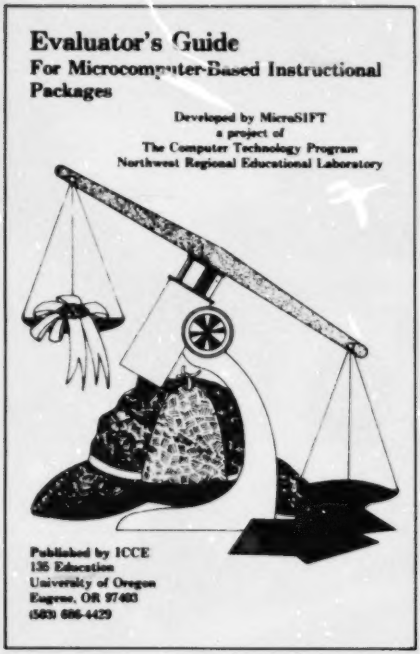

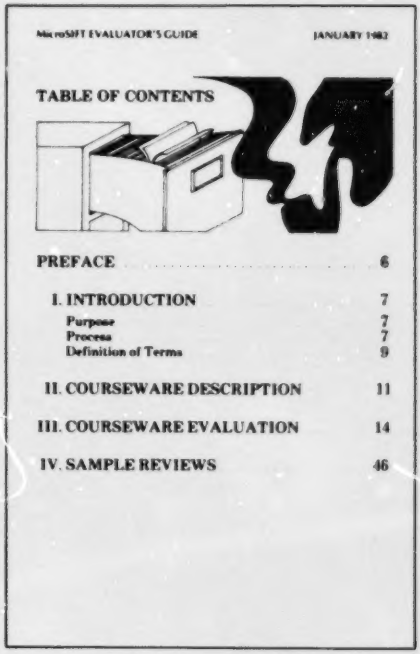

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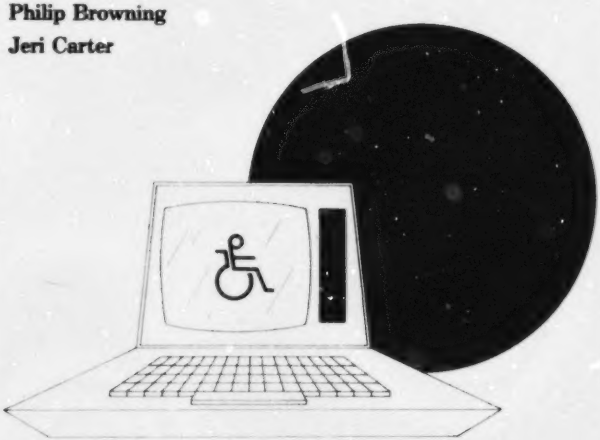

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